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SUBSTANTIATION FOR THE OPTIMAL STRATEGY OF RISK MANAGEMENT IN MARKETING COMMUNICATIVE ACTIVITIES OF PHARMACEUTICAL ENTERPRISES BASED ON MATHEMATICAL MODEL APPROACH

© A. Olkhovska, V. Malyi, I. Storozhenko

Мета. Розробка математичної моделі аналізу та оцінки ризиків у маркетинговій комунікативній діяльності фармацевтичних виробничих підприємств при просуванні нового лікарського засобу на ринок в умовах обмеження та (або) заощадження інвестиційних коштів на маркетингові комунікації. На основі отриманих результатів прийняти обґрунтовані рішення щодо вибору оптимальної стратегії управління ризиками у маркетинговій комунікативній діяльності фармацевтичних підприємств.

Методи. Для реалізації окреслених завдань дослідження застосовані методи контент-аналізу, логічного аналізу, групування та узагальнення, математичного моделювання та ін.

Результати дослідження. Запропоновано методіку аналізу та оцінки ризиків у маркетинговій комунікативній діяльності фармацевтичних виробничих підприємств при просуванні нового лікарського засобу на ринок із застосуванням теорії нечіткого моделювання в середовищі Fuzzy TECH. Розроблена математична модель дозволяє суб'єктам фармацевтичного ринку досить обґрунтовано та своєчасно оцінити вплив окремих ризикоутворюючих факторів на результати реалізації програми маркетингових комунікацій при просуванні нового лікарського засобу на ринок в умовах обмеження та (або) заощадження інвестиційних коштів на маркетингові комунікації, на основі отриманих результатів прийняти управлінське рішення щодо вибору оптимальної стратегії управління ризиками у маркетинговій комунікативній діяльності підприємств: ухилення від ризику, передача ризику, зниження ризику, прийняття ризику.

Висновки. Представлена математична модель має практичну цінність для суб'єктів фармацевтичного ринку, оскільки не чутлива до кількості вхідних змінних – при збільшенні або зменшенні кількості ризикоутворюючих факторів відповідно збільшується або зменшується кількість правил рішення, а логіка моделі при цьому не змінюється

Ключові слова: ризикоутворюючі фактори, стратегії управління ризиками, маркетингова комунікативна діяльність, фармацевтичні підприємства, математичне моделювання

1. Introduction

The modern marketing environment generates additional elements of uncertainty, expands the areas of risk situations. Under these conditions, there appears ambiguity and uncertainty in obtaining the expected result with further increased risk level in the activity of all market participants.

Functioning of pharmaceutical enterprises under the current state of the Ukrainian economy necessitates their adapting to possible risk situations in the external and internal environment. The marketing communication activities play an important role in providing timely responses and making sound decisions about choosing risk management strategy.

2. Formulation of the problem in a general way, the relevance of the theme and its connection with important scientific and practical issues

An important component in managing pharmaceutical manufacturing enterprises marketing activities is the level of development and application of marketing communications in medicine products promotion. This is of particular importance when there is considerable uncertainty and organization's environment volatility while introducing new products. Therefore, an urgent problem for the top management of the pharmaceutical enterprise is to take the sound

managerial decisions to minimize the risks associated with the introduction and promotion of new medical products in the market using marketing communications, the need to choose the best methods for the risks evaluation ensuring the accuracy and reliability of the expected results.

3. Analysis of recent studies and publications in which a solution of the problem and which draws on the author

The issues of risk management in various fields of activity of pharmaceutical organizations were covered in scientific publications of national and foreign researchers including. In particular, the paper [1] presents a research aimed at studying and assessing the risks accompanying the emergence and promotion of drugs to the market. The work [2] is devoted to the management of the risks associated with innovation in pharmacy and with the issues related to the quality of medicines. The author [3] presents practical experience of applying the risk management system in activities of pharmaceutical enterprises. The papers [4, 5] contains the structure of internal risk-oriented audits of the pharmaceutical quality system. In the paper [6], the author classifies the factors influencing the level of investment risks in the pharmaceutical sector. The author [7] presents risk management pharmaceutical company experience.

4. Allocation of unsolved parts of the general problem, which is dedicated to the article

However, the results of the analysis of advances and development results of national and foreign pharmacists indicate insufficient attention to a reasonable choice of risks management strategies in marketing communication activities of pharmaceutical organizations in promoting medicine products, which determined the urgency of the chosen research, its theoretical and practical significance.

5. Formulation of goals (tasks) of article

The aim of the work is to develop a mathematical model for analyzing and assessing risks in marketing communication activities of pharmaceutical manufacturing enterprises while promoting a new medicine product in the market under limiting and (or) saving investment funds for marketing communications. The obtained results allowed to make informed decisions as for choosing the optimal risks management strategy in marketing communication activities of pharmaceutical enterprises.

6. Statement of the basic material of the study (methods and objects) with the justification of the results

The object of research is the marketing communication activity of pharmaceutical enterprises; internal and external risks factors that may critically affect the promotion of new medicine products in the market, the volume of sales and significant marketing communications budget overrun; questionnaires of specialists in practical pharmacy.

The subject of the research is a set of theoretical, methodological and practical aspects of risk management in the marketing communication activities of pharmaceutical enterprises while promoting the medicine products on the basis of mathematical model approach.

The implementation of the above tasks predetermined the choice of the following methods: content analysis, logical analysis, grouping and generalization, mathematical model methods, etc.

In their marketing communication activities, pharmaceutical enterprises are subject to various risks when promoting medicine products. In doing so, the organizations tend to exclude any risk factors that adversely affect their overall business activity. Top management of pharmaceutical enterprises is interested in choosing sound strategies for risk management, optimal methods and tools for minimizing the negative effects of risk factors in marketing activities.

In the process of risk minimization, it is reasonable for pharmaceutical enterprise to choose a risk management strategy that will reduce their negative impact not only on the main economic indicators of marketing communication activities, but also on business activities in general. The top management of pharmaceutical enterprises needs to make such managerial decisions that will provide the necessary compromise between the achievements of key economic performance indicators and the threat of potential losses while introducing and promoting new medicine products.

Table 1 presents risk management strategies types and characteristics.

Table 1

Risk management strategies types and characteristics

Risk management strategies types	Characteristics
Risk avoiding strategy	Provides complete risk elimination from program, project, plan. It is necessary to provide response principles that will prevent risk materialization. This is the “expensive” strategy, as it makes refuse from certain works for some risks; change the objectives of the program, project, plan or, in the most radical case, refuse from them.
Risk transfer strategy	Transfers the effects of risk materialization and responsibility for response to a third party, while the risk itself is not eliminated. This strategy almost always involves financial expenses for transfer and receipt of financial compensation in case of risk materialization.
Risk reduction strategy	This is the most common strategy and can be applied to any risk, as it means lower risk probability or influencing program, project, plan.
Risk taking strategy	There are two variants of this strategy - active and passive risk taking. Active one forms time and money reserve for the elimination of risk materialization effects. Passive one assumes the existence of an additional (backup) plan to eliminate the consequences of the problem in the event of risk materialization.

Source: Compiled by the author based on the materials [8–12]

Choosing the best strategy for risk management in marketing communication activities will allow pharmaceutical enterprises to concentrate and reasonably allocate investment funds for the program of new medicine products promotion, to develop appropriate measures to minimize risks.

As a tool for creating a mathematical model, we applied the theory of fuzzy simulation within Fuzzy

TECH [13, 14]. The Fuzzy TECH program is freely available in the Internet. A fuzzy model development, which is the base for the top management of pharmaceutical enterprises to make sound managerial decisions on choosing the optimal risk management strategy in marketing communication activities while promoting new medicine products, contains certain steps (Fig. 1).

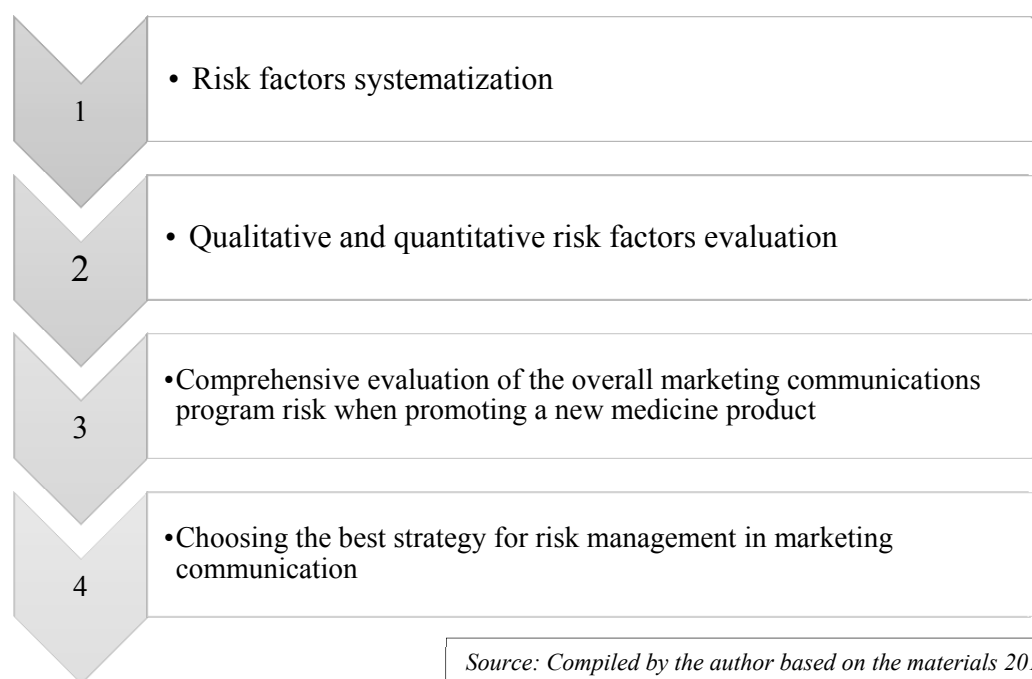


Fig. 1. The algorithm for evaluating the risk of a new medicine product promotion program in marketing communication activities of pharmaceutical manufacturing enterprises

Analysis of the scientific literature and practical activities of the pharmaceutical market subjects established that when promoting new medicine products in the market there may be different types of risks, including violation of the planned term of the product promotion program implementation; significant budget overrun of investment funds allocated to marketing communications for the goods promotion; failure to meet planned profit indicators and sales volumes of the medicines; critical divergence of the medicine product consumer properties relative to the analogues. The emergence of these risks is possible under the risk factors that we have previously systematized and grouped into external and internal ones according to the results of the interviews with the experts of the pharmaceutical sector in the health care.

According to the experts interviewed, the risk factors are the change in the legal framework and regulation of medicinal products circulation and promotion while applying various elements of marketing communications; exchange rate change (volatility); new medicine products in the pharmaceutical market (cheaper ones); distribution of counterfeit medicines; the competitors activity to form the negative image and reputation of the pharmaceutical enterprise in the market; mistakes in marketing communications budgeting, including lack of funds; higher costs of marketing communications than income; lack of experience in medicine products promotion technologies using various elements of marketing communications in marketing service of a pharmaceutical enterprise, etc. The list of risk factors can be supplemented taking into account the relevant situation in the market and the capabilities and objectives of the pharmaceutical enterprise.

At the next stage of the model development, a qualitative and quantitative assessment of the chosen risk factors is carried out.

To make quantitative evaluation and analysis of the risk factors influence on the results of the program implementation of marketing communications in the new medicine product promotion one should determine the probability of each factor manifestation and the level of their negative effects (losses). Taking into account the high degree of uncertainty, the description of risk factors is carried out on qualitative scales, with interval estimation being used for their quantitative interpretation [15, 16].

Using the approaches proposed by the scholars [16], we have adapted the scales of quantitative assessment of risk factors influence on the results of marketing communication activities of pharmaceutical enterprises in promoting a new medicine product, which are presented in Table. 2.

Further modeling requires specific linguistic rules, that is, the corresponding input and output variables are to be described linguistically, characterizing risk factors using the corresponding term sets [13, 14]. The following fuzzy term sets were applied in the model:

1. *Probability (P)* – input variable which determines the probability of the relevant factor manifestation: {unlikely (1), possibly (2), probably (3), highly probably (4)};

2. *Force (F)* – input variable which determines the probability of the relevant factor manifestation: F={insignificant (1), moderate (2), critical (3), catastrophic (4)};

3. *Power* – an intermediate output variable characterizing the degree of factor influence on the final risk of medicinal product promotion; that is, determines the strength of one or more factors, taking into account

their probabilities: $Power = \{low (1), lower\ than\ average (2), average (3), moderately\ high (4), high (5)\}$.

According to the marketing objectives of the program for a new medicine product promotion, one should specify the product sales volume and the investment funds budget for marketing communications. It is necessary to evaluate the risks of promotion program implementation taking into account risk factors in the communicative marketing activities of the pharmaceutical enterprise and to choose the optimal risk management strategies.

The model uses four levels of intermediate output parameters and corresponding rules blocks: the

first level is the X level, which determines the influence of each risk factor, taking into account its probabilities; the second level is the Y level, which determines the influence of the pair of factors; the third level is the Z level, which determines the influence of the whole group of factors; the fourth level is the level of external and internal factors influence “External_Power” and “Internal_Power”. The input source data is the Losses.

Then, using the expert evaluation method, one determines the probability of each analyzed risk factors manifestation and the effect of their impact on the final risk using a fuzzy rules matrix (Table 3).

Table 2

Scales of quantitative assessment of risk factors influence

Figures	Scales				
	Unlikely (<i>small</i>)	Possibly (<i>medium small</i>)	Probably (<i>medium large</i>)	Highly probably (<i>large</i>)	
Factor manifestation probability (<i>Probability</i>)	0.0 < P ≤ 0.25	0.26 ≤ P ≤ 0.40	0.4 ≤ P ≤ 0.60	0.6 ≤ P ≤ 0.8	
Possible losses in sales of medicines, budget increase of marketing communications program (the force of factor influence on the final risk) (<i>Force</i>)	Insignificant (<i>Low</i>)	Moderate (<i>Medium</i>)	Critical (<i>Critical</i>)	Catastrophic (<i>Tragic</i>)	
	≤ 1	2	3	≥ 4	
	Losses to 10 %	Losses from 10 % to 45 %	Losses from 45 % to 55 %	Losses over 55 %	
Factor influence degree (<i>Power</i>)	Low (<i>very_low</i>)	Lower than average (<i>low</i>)	Average (<i>medium</i>)	Moderately high (<i>high</i>)	High (<i>very_high</i>)
	1	2	3	4	5

Source: Adapted by the author based on the materials [16]

Table 3

The fuzzy rules matrix of the factor degree influence on the medicine product promotion final risk

Factor manifestation probability characteristic (P)	Characteristic of factor influence on the final risk (F)			
	Insignificant F (1)	Moderate F (2)	Critical F (3)	Catastrophic F (4)
Unlikely, P (1)	Low Power (1)	Lower than average Power (2)	Average Power (3)	Moderately high Power (4)
Possibly, P (2)	Lower than average Power (2)	Average Power (3)	Moderately high Power (4)	Moderately high Power (4)
Probably, P (3)	Average Power (3)	Moderately high Power (4)	Moderately high Power (4)	High Power (5)
Highly probably, P (4)	Average Power (3)	Moderately high Power (4)	High Power (5)	High Power (5)

Fuzzy TECH’s features allow to visualize the structure of the developed model and graphically present the interrelations of risk factors.

As an example of one of the risk factor, Fig. 2 shows the functions graphs of factor manifestation

probability membership, depending on the term sets of the model.

Membership functions graphs of one of the risk factor impact on the final risk, depending on the term sets of the model are presented in Fig. 3.

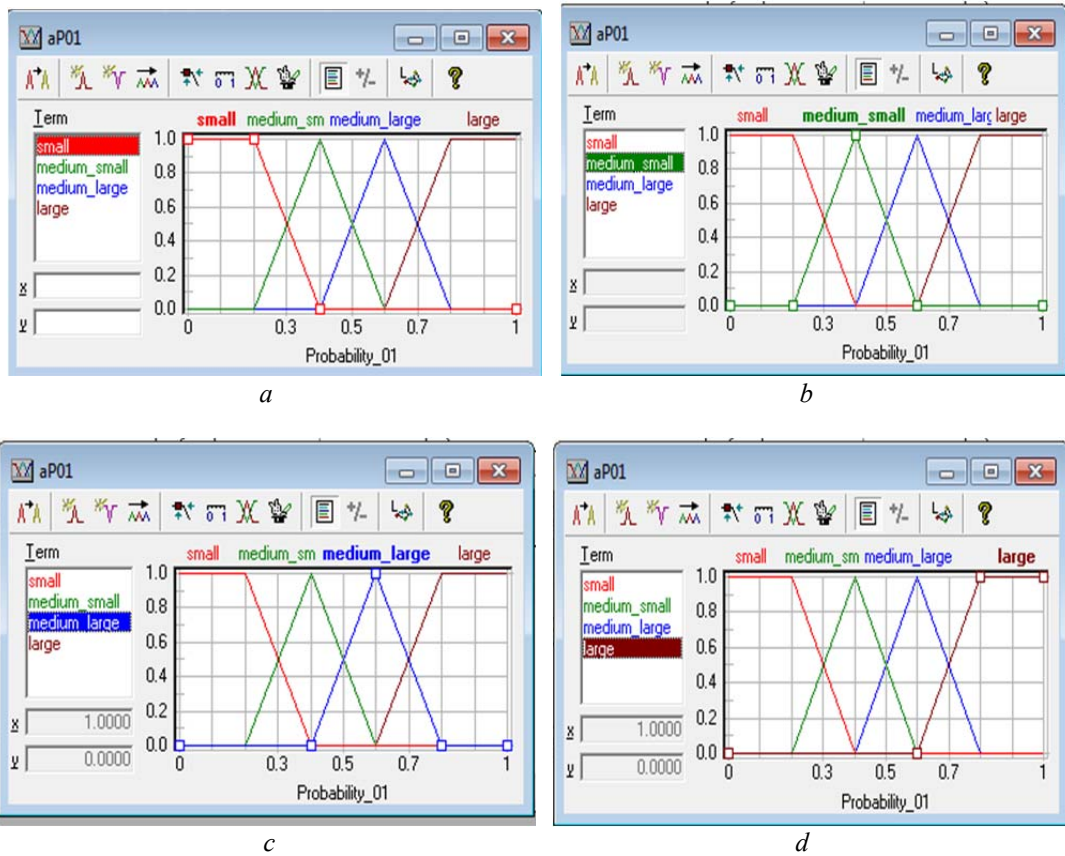


Fig. 2. Simulating the probability of risk factor manifestation depending on the model term sets: *a* – Unlikely; *b* – Possibly; *c* – Probably; *d* – Highly probably

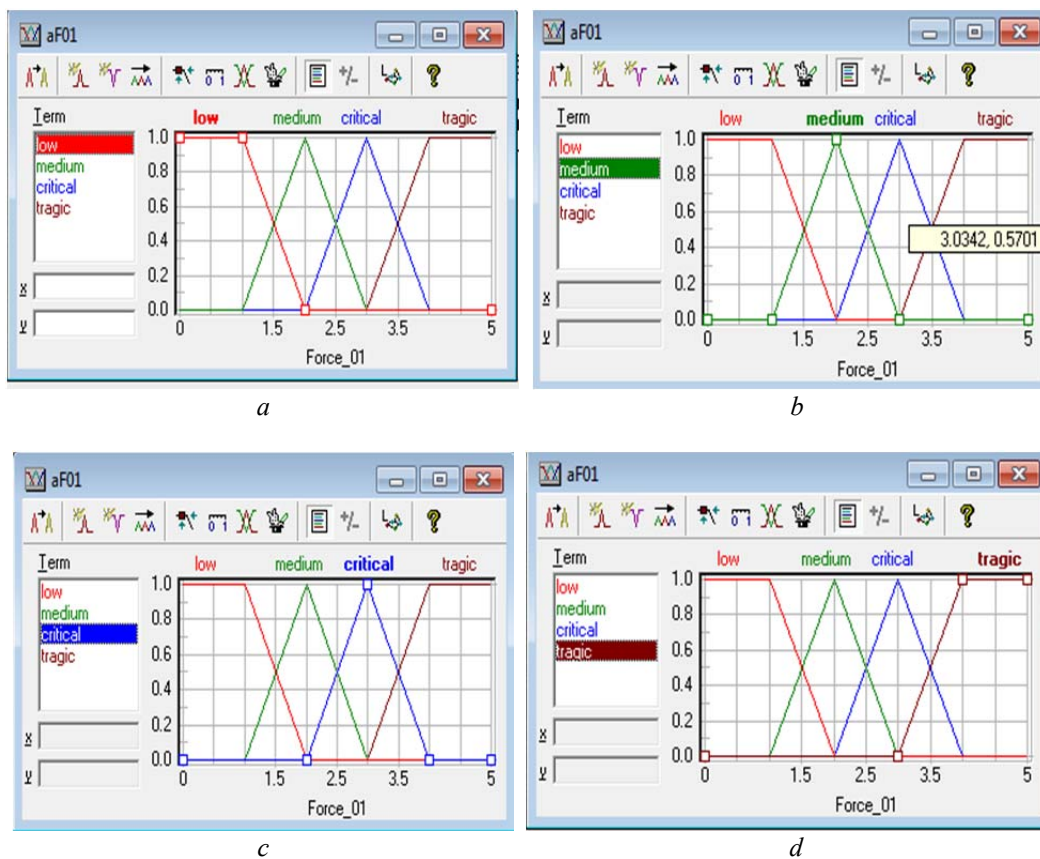


Fig. 3. Simulating the risk factor impact on the final risk depending on the term sets of the model: *a* – Insignificant; *b* – Moderate; *c* – Critical; *d* – Catastrophic

The final stage presents the three-dimensional surface of the fuzzy output model of the factor influence degree on the final risk, depending on the impact and manifestation probability. On the basis of the model, one of the possible risk management strategies is chosen in the marketing communication activity of the pharmaceutical manufacturing enterprise while promoting a new medicine product in the market. It is necessary to carefully choose the strategy for risk management. As a

reasonable strategy for risk management in the process of strategic development of a pharmaceutical manufacturing enterprise is based on the adaptive approach to the risk management.

Fig. 4 gives an example of a three-dimensional surface of a model of fuzzy output of the factor influence degree on the final risk, depending on the impact and probability of one of the investigated risk factors manifestation.

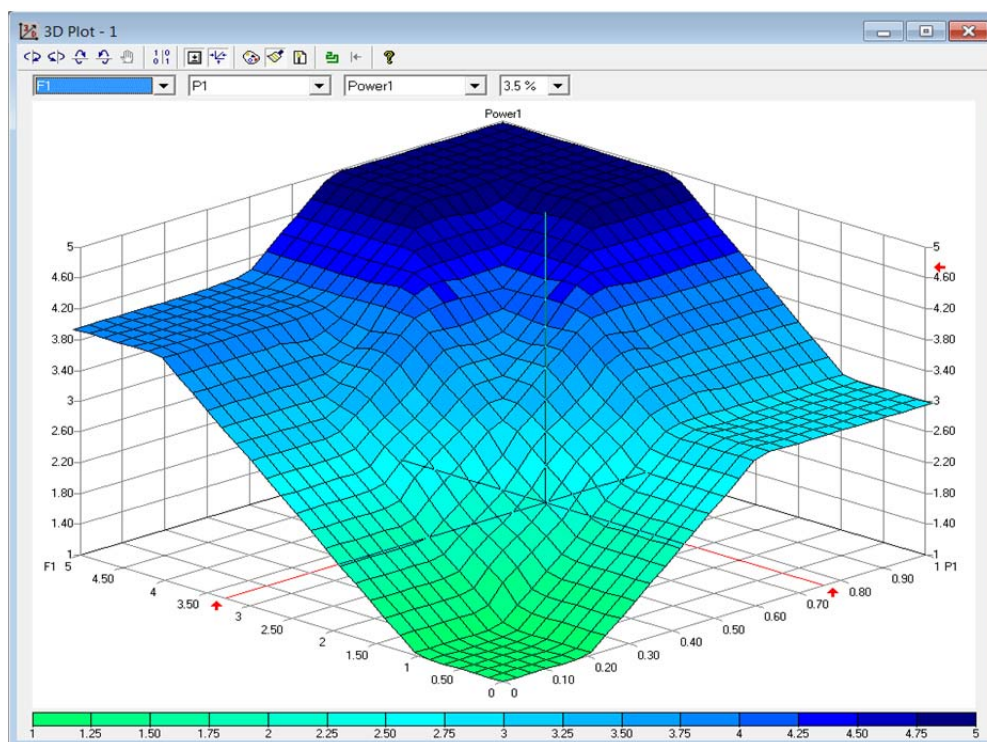


Fig. 4. An example of a three-dimensional surface of a model of fuzzy output of the factor influence degree on the final risk, depending on the impact and probability of one of the investigated risk factors manifestation

According to simulated results, with a high probability ($P=0.77$) of one of the external factors manifestation under research in the market, its impact on the final risk is above the critical value ($F=3.25$), and the degree of the above factor impact on the final risk marketing communications program while promoting a new medicine product is rather high ($Power=4.7$). It can be stated that once the external factor under research in the market, the losses in sales volumes of a new medicine product can vary from 45 % to 55 % for a pharmaceutical enterprise.

The top management of the manufacturing pharmaceutical enterprise should not neglect a sufficiently high dependence of the external factor impact on the final risk and recommend to choose such a risk management strategy to mitigate their impact on the overall sales volumes of the new medicine product and to increase the budget for marketing communications. In our opinion, such a strategy of risk management is a strategy for active risk taking, i.e., while implementing a marketing communications program, when promoting a new medicine product in the pharmaceutical market, a

reserve time and a budget for eliminating the effects of risk materialization should be formed in advance.

Approbation of the developed fuzzy model of risk analysis and evaluation has been carried out in the practical marketing communication activity of the leading national pharmaceutical manufacturing enterprise while promoting non-prescription medicine product. The developed model helped to simulate different situations of external and internal risk factors influence, quantitatively determined their influence effect, and the results of the obtained values calculated the percentage of possible losses in the medicine product sales volume and budget increase of the pharmaceutical enterprise marketing communications program.

Thus, for example, with the help of the developed mathematical model for a given advertising budget for promoting the medicine product under research and its planned sales volume, we have established that with the probability of $P=0.75$ of imposing the ban on advertising the medicine products, in particular on TV, the pharmaceutical manufacturing enterprise may experience 59.8 % of losses (Fig. 5).

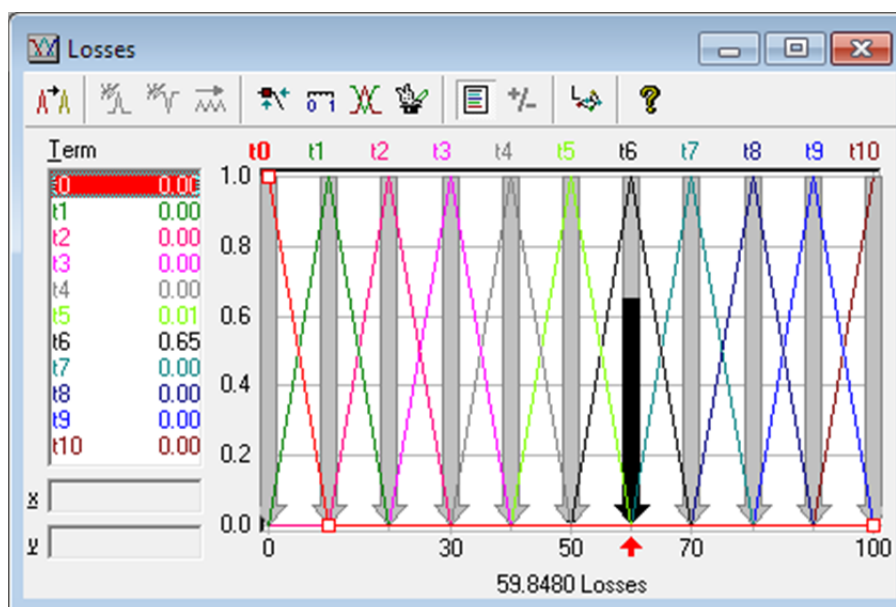


Fig. 5. The working interface configuration of the developed model using the Fuzzy TECH program: “Loss” output variable membership function

Based on the results of the investigated pharmaceutical enterprise top management, we recommended to choose two optimal risk management strategies – a risk transfer strategy and a passive risk taking strategy that finally allowed to save investment funds for promoting the medicine product.

7. Conclusions

1. The model allows to evaluate the influence of certain risk factors in the marketing communications activity of pharmaceutical enterprises on the final risk of possible losses in sales volumes and higher investment funds for the marketing communications budget while promoting new medicines in the market.

2. The presented model is not vulnerable to the number of input variables – higher or lower number of

risk factors leads to correspondingly higher or lower number of decision rules. There is no change in the model logic, which in its turn has a practical value for all subjects of the pharmaceutical market.

3. Thus, the proposed model allows the subjects of the pharmaceutical market to reasonably and timely evaluate the impact of individual risk factors on the results of the marketing communications program implementation when promoting a new medicine product in the market under limiting and (or) saving investment funds for the marketing communications, on the basis of the received results to make a managerial decision on choosing the optimal risk management strategy in marketing communication activities of enterprises: risk avoiding, risk transfer, risk reduction, risk taking.

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Anzhela Olkhovska, PhD, Associate Professor, Department of Pharmaceutical Marketing and Management, National University of Pharmacy, Pushkinska str., 53, Kharkiv, Ukraine, 61002
E-mail: angelika.olkhovskaya@gmail.com

Volodymyr Malyi, Doctor of Pharmacy, Professor, Head of the Department, Department of Pharmaceutical Marketing and Management, National University of Pharmacy, Pushkinska str., 53, Kharkiv, Ukraine, 61002
E-mail: malyi.vladimir@gmail.com

Ihor Storozhenko, Doctor of Physical and Mathematical, Professor, Department of Physics, National University of Pharmacy, Pushkinska str., 53, Kharkiv, Ukraine, 61002
E-mail: prof.igor.storozhenko@gmail.com

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TECHNOLOGY OF OBTAINING AND INVESTIGATION OF CHEMICAL COMPOSITION OF DENSE EXTRACT OF HAWTHORN FRUITS

© N. Sydora, S. Zuikina, A. Kovaleva, L. Vyshnevskaya

На фармацевтичному ринку України представлені рідкі лікарські форми глоду, які використовуються при комплексному лікуванні серцево-судинних захворювань. Українська флора нараховує понад 30 видів глодів, серед яких достатню сировинну базу мають неофіційні дикорослі та культурні види.

Мета. Розробити технологію одержання густих екстрактів плодів неофіційних видів глоду та встановити хімічний склад одержаних екстрактів.

Методи дослідження. Для визначення складу БАР густих екстрактів плодів глоду використовували спектрофотометричний метод та метод вискоефективної рідинної хроматографії (ВЕРХ).

Результати дослідження. Розроблена технологічна схема одержання густих екстрактів плодів глоду. Встановлено вміст амінокислот, флавоноїдів та гідроксикоричних кислот густих екстрактів плодів *C. prunifolia* Sarg., *C. pseudokyrstostilla* Klok. та *C. leiomonogyna* Klok.. Вміст флавоноїдів склав від 4,27%±0,01 до 10,94%±0,10; гідроксикоричних кислот - від 1,45%±0,02 до 2,56%±0,10. Методом ВЕРХ в усіх екстрактах ідентифіковано рутин, хлорогенову і ферулову кислоти. У густому екстракті плодів *C. prunifolia* Sarg. ідентифіковано апігенін-7-О-рамнозид; *C. pseudokyrstostilla* Klok. та *C. leiomonogyna* Klok. - апігенін-7-О-глікозид, апігенін, лютеолін; *C. leiomonogyna* Klok. - лютеолін -7-О-диглікозид та кверцетин.

Висновки. Одержано густі екстракти плодів *C. prunifolia*, *C. pseudokyrstostilla* та *C. leiomonogyna*. Вперше методом ВЕРХ в екстрактах встановлено вміст флавоноїдів та гідроксикоричних кислот. Проведено порівняльне дослідження амінокислотного складу одержаних екстрактів

Ключові слова: глід, плоди, густі екстракти, хімічний склад, технологія, флавоноїди, гідроксикоричні кислоти, амінокислоти

1. Introduction

Genus Hawthorn (*Crataegus* L.) is one of the polymorphous genus of the *Rosaceae* L. family and its representatives are widespread in Ukraine and in the world's flora. Having analyzed the raw material base and the degree of study of Ukrainian flora hawthorns, we concluded that attention should be paid to informal wild and cultural species, as promising sources of biologically active substances (BAS).

2. Formulation of the problem in a general way, the relevance of the theme and its connection with important scientific and practical issues

As a result of the study of the chemical composition of unofficial hawthorns, we have established BAS (amino acids, phenolic compounds, organic acids), which have different types of pharmacological activity [1].